The National Dose Assessments Working Group (www.ndawg.org) is an independent national committee whose members are drawn from regulators and government agencies, industry, local authorities, non-governmental organisations and specialists. It reviews and produces reports of best practice in the assessment of the radiation doses associated with the discharge of radioactive materials to the environment. Its views are those of the expert members rather than their parent bodies.

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Regulation and Risk of Radiation Exposure from Discharges

Q&A

NDAWG
National Dose Assessments Working Group

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Prepared by members of the Communications Subgroup of the National Dose Assessments Working Group.

This booklet presents the views of the majority of the members of the National Dose Assessments Working Group but does not necessarily reflect the views of the organisations from which the members are drawn.

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Department of Health, has reported on a number of epidemiological studies near nuclear facilities. These reports are a useful source of information and, in general, indicate that nuclear facilities and their discharges are not likely to be responsible for any detectable increased risk.

The only expected effect of low level radiation exposure is an increased risk of cancer. There are problems in assessing this risk, however, because there is no difference between a cancer caused by radiation (or any other pollutant) and that which occurs, apparently, spontaneously. The position is further complicated as there is a latent or lag period after exposure to any factor (or pollutant) before a cancer appears (this may be 5—50+ years).

Nevertheless, the risk at the doses received from radioactive material discharges in the UK is so low that it is unlikely, for the size of the population around a nuclear site, that an increase in cancer could reliably be detected unless the internationally accepted views of the risk presented by radiation exposure were substantially in error.

Regulation and Risk of Radiation Exposure from Discharges

Q1 What is the role of the site owner/operator?

The prime responsibility for the management of radioactive wastes and discharges from a nuclear (or non-nuclear) site lies with the operator who holds the site licence. Even where the site is not owned by the operator — for example, some NDA* sites — the operator must continue to maintain control of the discharges from the site. The routine discharges and, ultimately (after maybe hundreds or thousands of years) any radioactive material which gets into the environment from a waste repository, are potential radiation hazards to the public. To reduce these risks to as low as reasonably achievable, the site operators must use best practicable means (BPM)† to comply with the requirements of the regulators.

Q2 Who are the regulators and what is their role?

Exposure of the public to radiation as a consequence of the operation of a nuclear licensed site‡ is regulated by several agencies:

- the Environment Agency (EA)
- the Scottish Environment Protection Agency (SEPA)
- the Health and Safety Executive (HSE) through its Nuclear Installations Inspectorate (NII).

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* The Nuclear Decommissioning Authority (www.nda.gov.uk) is the non-departmental public body set up under the Energy Act of 2004 to manage the clean-up of the civil nuclear legacy of the UK.

† BPM requires operators to take all reasonably practicable measures in design and operational management of their facilities to minimise discharges and disposals of radioactive waste so as to provide a high standard of protection for the public and the environment. It takes account of a range of factors such as availability and the cost of relevant measures. This concept is broadly the same requirement as best available technique (BAT) which is replacing BPM.

‡ A nuclear licensed site is a site which is licensed under the Nuclear Installations Act (NIA 1965). These will include all nuclear power stations, nuclear fuel and reprocessing sites, sites undertaking storage of, and/or research into, nuclear materials, and major plant producing radioisotopes (NIA 1965 and Nuclear Installation Regulations 1971).

The EA and SEPA fulfil this responsibility by issuing authorisations which set limits on the amounts of radioactive materials that may be discharged by specified routes. They consult the Food Standards Agency (FSA) and the Health Protection Agency (www.hpa.org.uk) on food and health matters, respectively. The FSA has a statutory responsibility for food safety throughout the UK and is independent of the regulators and the nuclear industry. The HSE (using site licence conditions and the Health and Safety at Work Etc Act of 1974) ensures that the operator maintains the external (penetrating) radiation from the site as low as reasonably practicable below the public dose limit (see Q5).

Q3 How is compliance with the authorisation demonstrated?

Compliance is demonstrated by measurement of the actual discharges and comparing this against the authorisation. Although not part of compliance, monitoring of the environment and foods and the assessment of radiation doses is carried out by the FSA and the environment agencies.

Q4 Who does the monitoring?

Monitoring or regulation is carried out by various bodies, namely:

Agency	Monitoring responsibility
EA and SEPA*	Environment
FSA	Foods, crops, seafood, etc
HSE	External doses from the site

* In Scotland SEPA incorporates the monitoring requirements of the FSA within its own programme.

Site operators are required by the environment agencies as part of the licence for authorisation to discharge, to carry out monitoring of the environment and foods. This is also a useful role in the event of an emergency. The results, from the environment agencies, FSA and HSE, are published annually in the Radioactivity in Food and the Environment (RIFE) reports. Importantly, the radiation doses reported in RIFE include contributions from radioactive materials discharged in previous years.

probably undetectably small. For instance, the one in four normal risk of dying of cancer can be expressed as a 25% chance. A radiation dose of, say, 50 µSv (ie 50 millionths of a Sv) gives an added risk (using the factor described under Q8) of about 0.00028% – the difference between 25% and 25.00028% would be impossible to detect amongst the normal variations in cancer incidence.

Q10 How do the risks compare – are they acceptable?

The risk of a health effect from environmental pollutants such as radiation can be put into some sort of perspective by comparison with other similar risks, eg from chemicals in food. Consumers are exposed to some unavoidable carcinogens in food but at levels which are, presumably, considered acceptable because they are strictly controlled. For instance, just to consider one group, a number of polycyclic aromatic hydrocarbons (PAHs), of which benzopyrene is of greatest significance, occur in cereals, flour, bread, vegetables, cooked meats, food supplements and seafood. These are carcinogens but their contaminant levels are controlled by monitoring and comparison with internationally agreed limits, exactly as radiation doses are. The levels of PAHs in a normal diet with some seafood would present a probable annual risk of cancer of about 6–30 in 10,000,000 (the larger figure being for a high seafood consumer). For comparison, a typical radiation dose as a result of discharges of, say, 40 µSv presents a risk of about 22 in 10,000,000. These risks are considered acceptable but they do suggest that, at low (or 'environmental') levels, radiation risks are not very different from those associated with a normal diet but are, of course, in addition to it.

Q11 How do I find out about health statistics in my area?

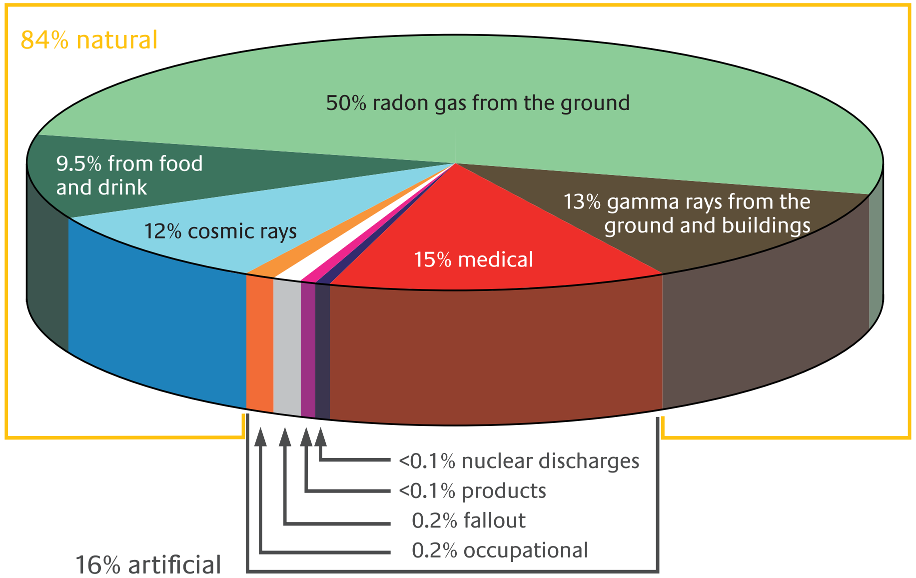
Health statistics are available from the Office of Population and Census Surveys (OPCS, www.statistics.gov.uk), which is part of the Office for National Statistics, over county regions and the Small Area Health Statistics Unit (at Imperial College, www.sahsu.org) has access to data which could be used to detect variations in smaller areas*. The Committee on Medical Aspects of Radiation in the Environment (COMARE, www.comare.org.uk), which is sponsored by the

* When considering small geographical areas, data on the incidence of cancer may be limited – this means that significant random fluctuations between different areas can be expected over time. It may therefore be impossible to distinguish statistically any measurable effect from such fluctuations.

Q9 Are the risks detectable?

In a modern, industrialised society there are many pollutants in the environment. Most of these present some risks which people accept because they are small and assumed to be controlled. Many quite common pollutants in food and the environment are known to be involved in the causation of cancer, eg benzene, nitrosamines, arsenic, paraffin oil, coal tar, tobacco smoke, asbestos, some chemical dyes, fungal toxins and viruses, and radiation. Thus radiation is just another pollutant but for which the risks may be better known than for many of the chemical pollutants which are in the environment. For most of these pollutants, including radiation, there is no threshold, ie no 'safe' level, but the risk increases from zero with increased exposure — this means that even natural background radiation, which varies quite significantly across the UK, will be responsible for a few per cent of all cancers.

The radiation doses from current discharges of radioactive materials are very small compared even to natural background doses (see the figure) so the overall risk is also very small. Overall about one in four people die of cancer in the UK. Most of these cancers are the result of random errors in DNA replication but which are influenced by diet and lifestyle. However, the numbers of cancers directly attributable to any particular *environmental* pollutant is



Average annual dose to the UK population — 2.7 mSv overall

Q5 What is the public dose limit?

The radiation dose limit for members of the public is the annual dose that will present a risk which is considered acceptable. The current value, which is one millisievert (1 mSv, ie one-thousandth of a sievert, Sv — see below) per year, has been derived from a comparison with the risks of modern living which the public experience and would consider broadly acceptable. Risk in this context is the probability or likelihood, not certainty, that there will be some health effect — for low level exposure to radiation this is an increased risk of cancer (see Q9).

Q6 How are authorisation limits set?

Authorisations are set so that discharges of radioactive material from one site, at the maximum permitted, do not give rise to a radiation dose to any member of the public which is above a planning dose* (which is about one-third of the public dose limit). Environmental 'predictive models' are used to estimate how the discharged material will be incorporated into crops, fish, etc. Habit surveys are also carried out to ascertain, for instance, how much local food is consumed and the time people spend in potentially contaminated areas. This information is then combined to provide estimates of people's likely exposure to radiation as a result of discharges. The modelling is typically based on conservative assumptions and, as discharges are usually well below the maximum permitted, results in estimates which are generally higher than actual doses. In comparing the doses assessed from discharges with either the dose limit or planning doses, consideration is also made of current levels of radioactivity in the environment and other man-made exposure pathways. The models used are subject to independent assessment by NDAWG.

* This is an annual planning dose (which is not expected to be exceeded) to a person from a single source of radiation exposure, eg the future discharges from a nuclear power station but not including pre-existing radioactive contamination of the environment. It is set as a restriction so that the aggregated dose from all sources (excluding natural background and medical procedures) does not exceed the dose limit of 1 mSv.

Q7 How are radiation doses to members of the public assessed?

Doses to the public arise from:

- doses from radioactive materials taken into the body from food and water
- external radiation doses from the site.

External doses (if detectable – see Q9) are easily monitored by radiation detectors placed around the site or by surveys using handheld monitors. Occupancy of these areas will have been established by surveys of individual habits. However, it may be difficult to distinguish these doses from natural background radiation (for more information on natural background radiation see www.hpa.org.uk).

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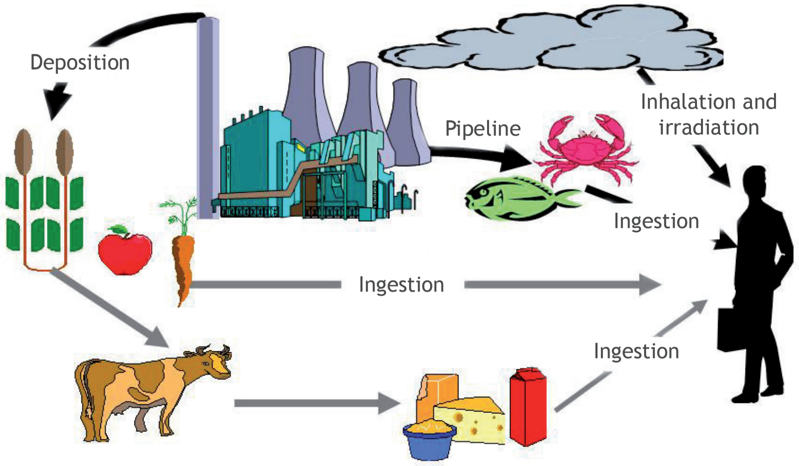
The doses from the intake of radioactive materials in food are not so easily assessed. However, in essence, they are estimated by multiplying the concentration of any radionuclide in a food, the amount consumed and an age-specific dose conversion factor (which converts the amount of radioactivity taken in, to the radiation dose to body tissues). This factor, determined by research, is a generic factor and therefore may not apply to all individuals – this implies some uncertainty in the resulting dose estimate. Other uncertainties are associated with assumptions which have to be made about such aspects as the actual consumption rates of food. However, this calculation is carried out for a representative member of the public (who may be hypothetical in that he/she does not currently exist near a particular site) who has extreme, but realistic, habits in terms of food consumption and/or occupation of contaminated areas. The principle being applied here that if such a person is protected, the rest of the population will also be. The figure below illustrates possible routes of exposure and intake.



Possible routes of exposure and intake

Q8 How are radiation doses converted into risks?

From the experiences of groups of people who have been exposed to large doses of radiation (notably the survivors of the atomic bombings in Japan in 1945), estimates have been made of the long-term effects of exposure to radiation in relation to dose. These estimates are, of course, subject to some uncertainty when applied to the environmental situation because, for example, they were derived from very high doses received in a very short period of time. However, the risks do seem to fit with those derived from large epidemiological studies carried out on radiation workers who received very much lower doses over many years, eg the NRRW study*. Usually these estimates are distilled into one 'risk factor' of contracting any cancer – for members of the public this risk is about 5.5 in 100 per Sv (the sievert or Sv is a very large unit of radiation dose) or roughly between 5 and 6 in 100,000 per mSv.

* This is the National Registry of Radiation Workers which includes all radiation workers in the UK. So far three epidemiological studies have been published which cover cancer and other diseases in about 125,000 workers.